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Neurochemical correlates of aestivation: Changes in the levels of glycogen and glucose in the cerebral, pleuropedal and visceral ganglia of the Indian apple snail, *Pila globosa*

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ABSTRACT

Changes in glycogen and glucose levels of cerebral, pleuropedal and visceral ganglia during aestivation in *Pila globosa* were investigated. In general, a decrease in the glycogen level of cerebral and visceral ganglia, and in the glucose level of pleuropedal ganglia was observed during aestivation. Blood glucose levels are depleted on aestivation. It may be concluded that carbohydrates served as energy sources during aestivation in *Pila globosa*.

1. INTRODUCTION

DURING aestivation, the energy requirements are known to be met with glycogen reserves in gastropod snails, *Helix*[1] and *Pila virens*[2] Nagabhushnam and Mantle[3] suggested that lipids and carbohydrates serve as energy reserves during aestivation in *Cryptozona*. However, information is lacking about the source of energy in the central nervous system of aestivating *Pila globosa*. Hence, the present investigation was undertaken.

2. MATERIAL AND METHODS

Indian apple snails *Pila globosa* were collected from the nearby fresh water ponds and were brought to the laboratory and kept in glass troughs at $24 \pm 2°$ C for six days. They were fed on *Hydrilla* plants. Actively feeding snails were aestivated by embedding them in dry sand[4–7] for eight months.

The animal was dissected on a wax plate kept on ice-blocks at 0° C. Cerebral, pleuropedal and visceral ganglia were isolated and kept in ice cold. *Pila Ringer*[3] in cavity glasses. The ganglia were pooled from five animals, weighed immediately, and were used for analysis.

Glycogen content was determined following the colorimetric method of Nicholas *et al.*[8] Glucose levels in the blood (collected by bleeding) and ganglia were measured by the method of Folin as described by Oser[9] (1965).

3. Results and Discussion

The data after statistical analysis is presented in tables 1 and 2.

Table 1. Changes in glycogen content on aestivation in cerebral, pleuropedal and visceral ganglia of *Pila globosa.*

(Values are mg glycogen/gm wet weight of the tissue)

Snails used	Cerebral ganglion	Pleuropedal ganglion	Visceral ganglion
Normal	1·71±0·17 (6)	2·79±0·18 (6)	5·50±0·14 (6)
Aestivated	1·30±0·28 (6)	2·78±0·17 (6)	5·35±0·16 (6)
Per cent change	−31·5 P > 0·01	− 0·4 NS	− 2·8 NS

Values are mean ± SD.
Number in parentheses indicates the number of observations.
Ganglia from 5 animals were pooled for each estimation.
NS — not significant.

Table 2. Changes in the level of ganglionic[1] and blood[2] glucose in *Pila globosa* as a consequence of aestivation

	Normal snails	Aestivated snails	Per cent change
Cerebral ganglia	14·94±0·162 (4)	13·90±1·24 (4)	−7·4*
Pleuropedal	16·34±0·174 (4)	10·36±0·148 (4)	−57·7†
Visceral	14·54±1·35 (4)	13·78±1·823 (4)	−5·5*
Blood	15·1±0·0002	3·8 ±0·013	−297*

Values are mean ± SD.
Number in parentheses indicates the number of observations.
For each observation ganglia from 5 animals were pooled.
[1]Values are mg glucose/gm wet weight of the tissue.
[2]Values re mg glucose/100 ml.
* The differences are not significant.
† Significant P > 0·01.

It is clear from the results (table 1) that the visceral ganglion has the highest glycogen content in normally active *Pila*. In general, the level of glycogen in the cerebral ganglion of normally active (control) and aestivated (experimental) *Pila* is less. Negligible change in glycogen level was observed in pleuropedal ganglion during aestivation (—0·4 per cent) and the cerebral ganglion exhibited the relatively highest response (per cent decrease is 31·5)

Relatively the level of glucose is highest in the pleuropedal ganglion of the control and lowest in the pleuropedal ganglion of the experimental snails (table 2). In general, a decrease in glucose level is exhibited on aestivation (— 7·4 in cerebral, —57·7 in pleuropedal and —5·5 in the visceral ganglia).

Thus it is evident (table 2) that the minimum response for the change in glucose level was exhibited by the pleuropedal ganglion on aestivation.

A remarkable feature of the present study was the inverse interrelationship of glycogen and glucose levels exhibited by the pleuropedal ganglion during aestivation. Therefore, it can be said that the maximum response was felt by the pleuropedal ganglion during aestivation.

Such differences in the level of glycogen and glucose (in the different ganglia of control and experimental snails) and the magnitude of response during aestivation are related to the differences in the functional status of concerned ganglion.

In general, considerable decrease in the level of glycogen and glucose in cerebral and visceral ganglia was observed during aestivation. Earlier studies also indicated changes in the level of glycogen in different tissues of gastropod snails.[1–3] However, the negligible decrease in the level of glycogen and maximum decrease in the level of glucose in the pleuropedal ganglion also indicates that the energy requirements of this ganglion is met with from the glucose from the blood supply. In support of this, significant decrease in the level of blood glucose was detected during the present study (table 2). It is, therefore, possible that the glycogen content is not depleted in the pleuropedal ganglion during aestivation in *Pila*.

Similar results were reported in the foot muscle of *Pila globosa* during aestivation and it was suggested[2] that the glycogen is not a source of energy during aestivation in *Pila*.

But in the present study a significant decrease in the level of glycogen in cerebral (table 1) and glucose level in pleuropedal ganglion (table 2) was observed. This suggests that the carbohydrates may act as a source of

energy during aestivation in these ganglia. This is in accordance with the earlier observations made in *Helix*[1] during aestivation, and *Cryptozona*[6] during hibernation. Meenakshi[5] also suggested that the energy requirements are met with the glycogen catabolism in *Pila virens* during aestivation.

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